1987

Laboratory Stations in Electrochemistry

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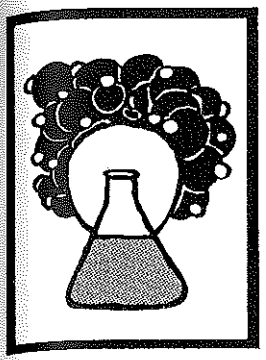

CHEMISTRY

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LABORATORY STATIONS IN ELECTROCHEMISTRY

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This article describes the use of seven laboratory stations involving the construction of electrochemical cells. The laboratory exercise has been used with a year 12 chemistry class of twelve students. The class was divided into six groups of two and assigned a laboratory station at which to commence work. When finished the task at each station a group was allowed to move to a vacant station which they had not yet completed. I have found that having seven stations for six groups enables this process to work reasonably well. One could also have six stations for six groups with a time limit for each station. When the time is completed the groups move together to the next station in line. Laboratory stations can also be used for assessment of practical work. This particular practical exercise works best with one or two students.

The author prepared seven instruction sheets with one for each station. An example of an instruction sheet is given in Figure 1. The lay-out of the laboratory station matching the instruction sheet in Figure 1 is shown in Figure 2. From the basic materials present at the station the students are to construct a cell and measure the voltage obtained. On their worksheet they are required to draw the constructed cell showing and naming all the components; to indicate the direction of electron flow in the external circuit; to indicate the anode and cathode; to indicate the positive and negative terminals on the cell and the voltmeter; and to write the total cell reaction. The author has used salt-bridges of two types for this laboratory exercise. One consists of a U-tube with cotton wool in each end to contain the electrolyte and the other simply consists of a strip of filter paper soaked in the electrolyte. The electrolyte used in each case is 0.1M potassium nitrate. Fresh filter paper or cotton wool should be available for each group. The students are required to dismantle the cell when finished and to leave the station in a clean and tidy condition for the next group.

The materials at each station were designed to give the half-cell components shown in Figure 3. All such cells constructed give an easily measurable voltage on the 0-3V or 0-5V range on a voltmeter. The author has found it advisable to use solution concentrations other than 1M so that students are not led to expect the voltmeter to give an E° reading. Students find it somewhat mystifying why 1M solutions at 25° C don't yield E° values on the voltmeter. This can be explained, of course, in terms of a voltage drop across the cell when a current is flowing but in this laboratory exercise one is primarily concerned with the students' ability to construct the cell and to understand its basic functions.

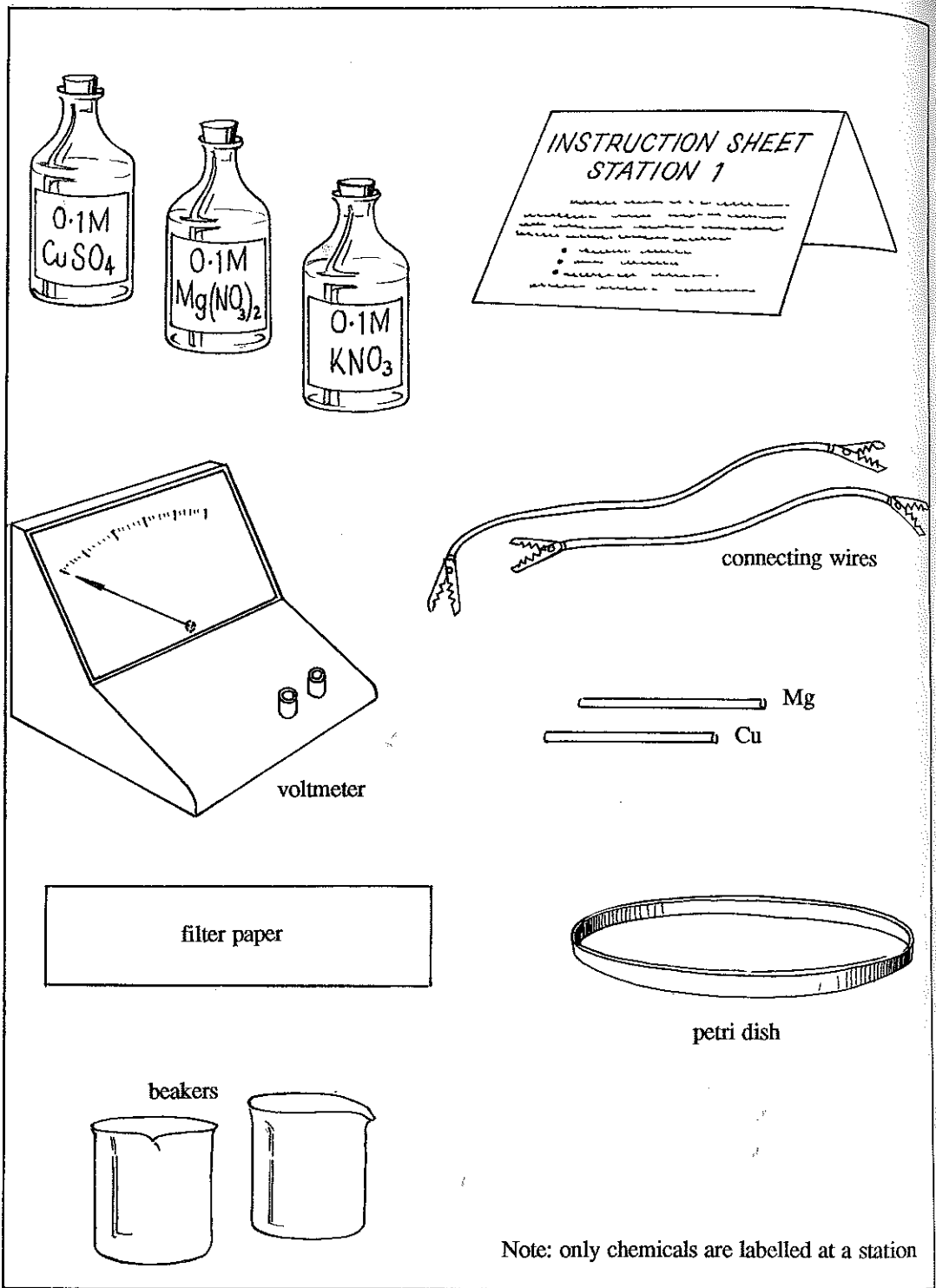

FIGURE 2: Layout of station 1

INSTRUCTION SHEET: STATION 1

At this station you will find the following materials:—

0.1M copper (II) sulfate
0.1M magnesium nitrate
0.1M potassium nitrate
Voltmeter
Connecting wires
Magnesium ribbon
Copper rod
Salt bridge
2 beakers

Construct an electrochemical cell using these materials and then draw a diagram of your cell in your workbook indicating:

all components; anode and cathode; positive and negative terminals of cell & voltmeter; electron flow direction in external circuit; total cell reaction; voltage of the cell

FIGURE 1: Instruction sheet for station 1

The teacher will need to give some guidance on determining the polarity of the cell electrodes. This can be done simply by observing the deflection of the voltmeter needle or by getting students to predict the probable polarities by using E° tables and then comparing their prediction with experiment. Guidance is also needed in the handling of bromine solutions. The station involving the use of bromine water is usually set up in a fume cupboard with gloves available for handling the solutions. Any mixtures of solutions made up from pure solutions must be discarded when a cell is dismantled for the next group's visit. For chlorine water solution, the use of 4% sodium hypochlorite solution is found to give satisfactory results.

I have found this laboratory exercise gives a challenge to the bright students but also a taste of success for students who usually find chemistry difficult. Whilst some mistakes are initially made by students in setting up the cells they are usually quite proficient at the process by the time they finish the practical.

HALF-CELL COMPONENTS FOR EACH STATION

Station Number	Halfcell 1	Halfcell 2
1	$Cu/CuSO_4$	$Mg/Mg(NO_3)_2$
2	$Cu/CuSO_4$	$Pb/Pb(NO_3)_2$
3	$Ag/AgNO_3$	$Mg/Mg(NO_3)_2$
4	$Cu/CuSO_4$	$Zn/Zn(NO_3)_2$
5	$C/FeSO_4$ $Fe(NO_3)_3$	$Zn/Zn(NO_3)_2$
6	C/Br_2 in H_2O NaBr	$Zn/Zn(NO_3)_2$
7	C/Cl_2 in H_2O KCl	$Fe/FeSO_4$

Note: Half-cell numbers have no significance other than identification.

FIGURE 3: Half-cell components for each station